Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

BARLEY
PRODUCTION IN CALIFORNIA

C. W. SCHALLER
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CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

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BARLEY
PRODUCTION IN CALIFORNIA

Barley is California's most widely distributed and grown cereal crop. It is produced in all counties, under a wide variety of conditions. This manual provides general information on the main aspects of barley growing in the state. It discusses the two principal cropping patterns—dryland and irrigation farming; takes you through all production stages—from seed-bed preparation to harvesting and storage; examines the diseases and insects of barley and their control; and summarizes the main characteristics of the major varieties used in California.

UNIVERSITY OF CALIFORNIA
DIVISION OF AGRICULTURAL SCIENCES
California Agricultural Experiment Station—Extension Service

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Data in one or several of the tables in this publication were developed by C. A. Suneson, G. A. Wiebe, F. N. Briggs, L. L. Davis, George Worker, Jr., John R. Goss, and many Farm Advisors. California acreage figures are taken from California Crop and Livestock Reporting Service reports.

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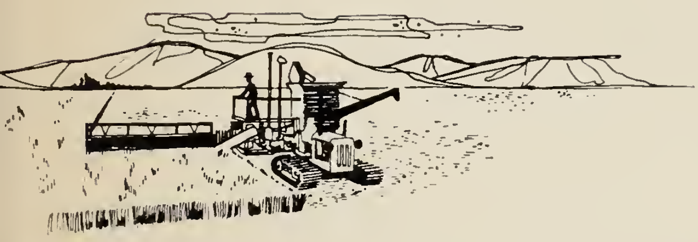
BARLEY

PRODUCTION IN CALIFORNIA

A State-wide Field Crop Produced
Under a Variety of Conditions



CHARLES W. SCHALLER and MILTON D. MILLER

Barley is California's most important grain crop. Introduced by the Spanish missionaries about 1771, its acreage has expanded over the years until in 1957 California growers harvested an all-time high of 1,967,000 acres, with a record production of 78,680,000 bushels. Approximately 35 per cent of the land in California devoted to field crops is planted to barley. On a national basis, California produces about one fifth of the U. S. total.

Barley is produced in all counties of California, under a wide diversity of environmental conditions. It is grown all year round: harvesting begins in the Imperial Valley before planting is completed in northern California, and harvesting in the north barely ends before planting starts in the south. Barley is grown on fields ranging from below sea level to elevations exceeding 5,000 feet. As a dry-farmed crop, it is grown in areas with an annual rainfall ranging from less than 8 inches (in an alternate fallow system) to as much as 35 inches or more (annual cropping). In very low rainfall areas, as in the southern San Joaquin or Imperial valleys, practically all moisture required by the crop is applied by irrigation. Under such a diversity of conditions no one cropping practice nor variety will suffice for all.

This manual provides general information on the various aspects of barley growing. If you need specific cultural recommendations for your particular situation, go to the University of California Farm Advisor in your county.

ADAPTATION

Barley is the most widely distributed and grown cereal crop. Although considered a cool-weather plant, it will withstand high temperatures in the absence of humidity. It grows better with moderate than with excessive rainfall. In many areas, use of early maturing varieties will allow the crop to escape drought and mature before the onset of high temperatures. In California, barley is better

suited for late planting than either wheat or oats.

In the valleys and at lower elevations the true spring types have sufficient cold tolerance to permit their planting in November and December. At the higher elevations these spring or nonhardy types will not withstand the winter temperatures and must be spring-sown. In general, most of the true winter-type varieties used elsewhere in the United States do not have sufficient winter hardiness to permit fall sowing at higher elevations in California.

Barley prefers soils that are well-drained and moderately fertile. Excessive lodging occurs when grown on soils of extremely high fertility. It is less adapted than either wheat or oats to production on heavy, poorly-drained soils, such as the typical rice soils. Barley is more tolerant of alkali conditions than the other cereal crops.

Although barley is grown in all parts of the state, the greatest concentration is in the San Joaquin Valley which accounts for approximately 45 per cent of the total production. Sacramento Valley produces about 15 per cent, the coastal counties 12 per cent, southern California 20 per cent, and other sections, including the Tulelake area, 7 per cent.

USES OF BARLEY

Barley is the chief feed grain grown in California; approximately 70 per cent of that produced is used for feed. It is either ground or rolled before feeding. Approximately 6 per cent is used for domestic malting, including both the two-rowed and six-rowed types; 5 per cent is used for seed; and an average of 18 per cent is exported. The amount exported fluctuates widely, ranging in recent years from 11 to 27 per cent; it is used both for feed and as food for human consumption in the importing countries.

Since the advent of smooth-awned varieties, barley has become a strong competitor with oats as a hay crop, either alone or in combination with vetch. In years unfavorable to grain production, considerable acreage which was planted for grain is cut for hay. Increasing acreage is planted early each fall solely for winter pasturage.

CROPPING PATTERNS

Barley production now follows two general cultural patterns—dryland and irrigation farming. Common under dryland conditions are continuous grain; alternate crop and fallow; and short rotations of barley, pasture and fallow. On irrigated land, barley may be grown in a rotation as a dry crop or with supplemental application of water.

Under Dryland Conditions

Continuous grain. Under valley conditions an annual rainfall of between 16 and 18 inches is considered enough for annual cropping. In cooler coastal areas 12 to 14 inches may be sufficient.

The alternate crop and fallow system is common in areas of less than 12 to 14 inches average rainfall in which the moisture available in any one year is insufficient to produce a crop. In addition to conserving moisture, several other benefits may accrue from incorporating a fallow year into the cropping system, one of the most important being weed control. Even in areas where sufficient moisture is available for annual cropping, fallowing every third or fourth year is essential to control weeds, including wild oats. Under proper moisture conditions throughout the fallow year, microbial activity is encouraged, making

available more nitrogen from decomposing organic matter and nonsymbiotic nitrogen fixation.

The alternate crop-fallow system also provides an opportunity to improve the physical condition of the soil through the incorporation of crop residue and an occasional green manure crop. Until some satisfactory method is devised permitting the incorporation of crop residue in annual dry-farmed cropping without depressing yield of the following crop, the organic matter management aspect of fallowing will become increasingly important on our dry-farm lands. Fallowing also permits more timely planting, since the seedbed is prepared the previous spring. Timely planting is important in all areas, but assumes greater importance on the clay-textured soils on which it may be impossible to establish a stand after the beginning of the winter rains.

Short rotations. Where annual rainfall is 15 inches or more, numerous operators have successfully and profitably employed a rotation system alternating a year of dry-farmed barley with a year of Sudangrass. This system is especially popular in coastal counties from Mendocino County southward.

On irrigated land

Barley returns normally are not high enough to warrant heavy expenditures for irrigation. However, barley will respond to irrigation in the drier areas, and occupies an important place in such areas in the rotation system. The increasing tendency of double cropping has encouraged the use of barley on irrigated land of this type. Pre-irrigation followed by one or two crop irrigations, if properly timed, generally have proved very profitable.

SEEDBED PREPARATION

An ideal seedbed for fall-sown grain should be firm beneath and moderately cloddy on top, free from weeds and residue (when residue is not needed for erosion control). For spring planting the seedbed should be firmer and relatively free from clods, with good soil moisture near the surface.

Tillage. Because barley is grown under a wide diversity of conditions, no one method of seedbed preparation is applicable in all cases. The purposes of tillage, in addition to mechanically arranging the soil in a suitable seedbed condition, are: to destroy weeds, incorporate plant residue, promote the activity of desirable soil organisms and reduce runoff and erosion. From among the many different kinds of implements available select those which accomplish these purposes with the least expenditure of labor and materials. The equipment commonly used for the initial operations are offset disks, wheatland plow, chisel or, in some areas, the moldboard plow. Equipment used for the final stages of seedbed preparation are tandem disks, spring and spike-tooth harrows, CC cultivators and rod weeders. The number of operations and types of tools used will vary with soil type, previous crop, crop residues and volunteer plants, amount and time of rainfall and the terrain. Choose that combination of tools which will result in a good seedbed for your particular conditions.

The moldboard plow provides the most complete coverage of the residue, usually resulting in higher production, but also increases the hazards of erosion. A number of implements, such as the duck-foot cultivator, permit stirring of the soil with minimum straw mixing. Disking, followed by plowing, gives a fair degree of mixing and also helps protect the soil.

Deep tillage. Practice deep tillage (deeper than 6–8 inches) with caution and use only when sufficient time elapses

Plowing barley land near Montague, California. The tractors are each pulling two 4 bottom 16-inch moldboard plows, starting the summer fallow operation. Where soil erosion is not a factor, the residue should be completely covered.

between plowing and planting, to permit settling of the soil. Deep tillage at planting time leaves the soil too loose for a satisfactory seedbed and allows excessive loss of moisture. Roots will penetrate undisturbed moist soil with ease, unless restricted by natural or artificial hardpans.

Plowing, chiseling or disking at the same depth year after year may cause an artificial hardpan known as a plow sole. You can avoid this by annually varying the depth of tillage. Subsoiling is seldom permanently beneficial, unless required to break up a hardpan or plow sole below a depth which can be reached by ordinary tillage implements.

Final seedbed tillage. Restrict final tillage to that required to produce a satisfactory seedbed. Excessive tillage results in an extremely fine seedbed which may be subject to crusting. With late spring planting or after the period where heavy rains may induce soil crusting, it may be desirable to roll the soil to produce a firmer seedbed.

Straw in soil. Incorporating large quantities of straw into the soil may have a depressing effect on the following grain crop, especially with annual cropping in low-rainfall areas. Considerable nitrogen that is required by the growing plant is temporarily tied up by microbial activity in decaying the straw. Because of this, removing the straw by pasturing or burning commonly results in greater yields of the succeeding crop but, if continued too long, will hasten the depletion of organic matter in the soil and result in a poor physical condition. You can partially offset the depressing effect on subsequent crops by judicious application of nitrogen fertilizer at or near planting time. Use approximately 15 to 20 pounds of elemental nitrogen (75–100 pounds of 21 per cent ammonium sulfate or equivalent) per ton of straw turned under, in addition to the usual amount of fertilizer required for the crop. Since much of this nitrogen will eventually be available to the crop, excessive application may have harmful effects on the yield of the new crop.

Under the fallow system, the straw is usually sufficiently decomposed during the fallow year so that no deleterious effect is noticeable on the following crop.

The partial incorporation of straw and stubble into the soil, leaving a trashy condition on the surface, effectively reduces wind and water erosion. Such erosion control is necessary and advisable on much of the grain land, especially in hill areas. However, decomposition is hastened by complete coverage. Therefore, unless needed for erosion control. practice clean cultivation whenever possible. Incomplete incorporation of crop residues as used in trashy fallow can result in build-up of soil-borne diseases.

Tillage for continuous grain culture

With continuous annual grain culture, you have little opportunity to vary your production practices. Usually the soil is too dry after harvest for immediate tillage operations, and the soil is left undisturbed until after the first fall rains. Unless the weed seeds are permitted to germinate before tillage, the soil will soon become heavily infested with weed seeds, especially wild oats. In fall-seeding areas, after the weed seeds have germinated, till the land to a depth of 4 to 7 inches, and immediately disk, harrow and plant. Cover completely the crop residue from the preceding crop unless you need it for erosion control.

In areas where it is necessary to plant in the spring, the entire operation may be delayed, especially where erosion is severe. However, initial fall tillage, involving the heavier seedbed operations, followed by shallow tillage in the spring, produces a firmer, more satisfactory seedbed than a delay of the entire operation until spring.

Regardless of rainfall, dry-farmed, clay-textured, poorly drained soils are difficult to crop annually. The usual fall, winter and spring rainfall distribution is such that it interferes with tillage for weed control, seedbed preparation and planting operations. Annual cropping works best on well-drained permeable soils.

Even with the best of management, land cropped annually to grain usually becomes infested with troublesome weeds, and it is advisable to include a fallow every third or fourth year. In addition to weed control, this occasional fallowing also provides an opportunity to incorporate organic matter (crop residues and green manure) into the soil, thus improving the physical condition of the soil.

Tillage for alternate crop-fallow

The alternate crop-fallow system permits some flexibility in management. The benefits derived from this system depend largely on your management practices.

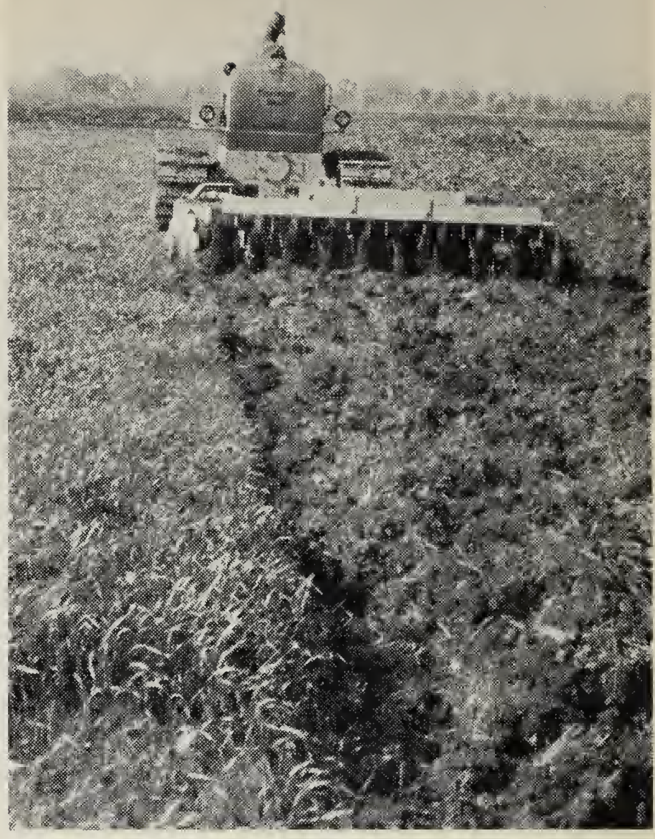
Where rainfall is low, the main objective is to conserve moisture for the crop year. The efficiency of your operation will depend on your success of capturing most of the rainfall by reducing losses from runoff, evaporation and volunteer utilization. For maximum water retention, prepare the land as early in the fall as possible in such a manner, as to provide a cloddy, trashy condition as a natural impediment to quick runoff. In areas where erosion is especially troublesome (such as hillsides) incorporate crop residue in such a way that some is left in the immediate surface; this will help reduce runoff. Subsequent tillage to eliminate all volunteer growth is essential. Volunteer winter growth may necessitate additional harrowing or shallow disking or plowing in the spring. During the next spring and summer season, employ shallow tillage by harrowing only when necessary to eliminate growth and to close soil cracks which may develop. You may reduce spring and summer tillage by using well-timed 2,4-D sprays for control of morning glory and other broadleaved weeds.

Such management practices will provide for maximum water storage in the soil, but increases the hazard of erosion and reduces the opportunity to incorpor-

ate green manure or to pasture volunteer growth. It also is costly since it requires tillage operations both in the fall and spring, even in noncrop years.

Where moisture conservation is less critical, it is better to leave the land undisturbed during the winter, permitting volunteer growth. Start fallow cultivations in the early spring. Pasturing the volunteer growth eliminates the advantage of improving the physical condition of the soil through the incorporation of the green growth. Since the loss of moisture by transpiration increases rapidly with increased plant growth and high temperature, the longer the fallow is delayed. the greater the loss of moisture from the soil. In any case, start the fallow early enough so adequate rainfall can settle the soil early in the year in order to reduce the moisture loss from the surface layers. This will allow the decomposition of the incorporated material and the release of organically bound plant nutrients. Usually a shallow plowing or disking, deep enough to permit coverage of the plant material, followed by a harrowing and subsequent summer tillage to control weeds will be sufficient.

Proper maintenance of the weed-free fallow during the summer usually will produce an excellent seedbed for the following crop. However, you may delay fall planting until after the first rains to provide an additional cultivation for weed control. Planting too early before the time when continuous rain is assured, may result in partial germination and loss of the seedling stand by drought. Occasionally, with a well-managed fallow, you may be able to maintain enough moisture near the surface to germinate the seed and to sustain plant growth until the first rains.



Where heavy stubble or a nonlegume green manure crop is turned under ahead of seeding the barley crop, use 15 to 20 extra pounds of nitrogen fertilizer per acre to speed decomposition of the incorporated organic matter. This is above the fertilizer normally planned for the barley crop. Sutter Basin, California.

Tillage for rotation with other crops

This system is normally practiced on irrigated land. Follow tillage operations which would produce a moderately firm, slightly cloddy seedbed, free from weeds and crop refuse. The practices followed and implements used will depend upon the preceding crop; they are similar to those discussed on pages 6 and 7.

TIME OF PLANTING

Barley is a cool-weather crop. Planting should be timed to insure the maximum use of winter rainfall and to avoid excessive summer temperatures and warm-weather diseases. Throughout the major portion of California, except in northern mountain valleys at elevations of around 3,000 feet or more, the best planting months are November, December and the first part of January. The effect of

Early Planting Dates Produce High Yields

Planting date	Location: Average yield expressed in per cent of November planting date	
	Davis (6-year average of 5 to 10 varieties)	El Centro (4-year average of 2 varieties)
November	100	100
December		82
January	94*	72
February	54†	45

* Higher than normally expected under commercial conditions.
† Includes late February and early March dates.

different planting dates on yield as measured in the Imperial Valley and at Davis, California, is given in the table. In all cases, the earlier planting dates produced the highest yield.

Extremely early planting, especially on fertile soil, may cause excessive growth, and result in the exhaustion of moisture (when dry-farmed) or lodging. In addition, diseases such as yellow dwarf virus, scald and net blotch have been serious in barley seeded earlier than November 15. Do not plant California Mariout in the Sacramento Valley before the first part of January since it may be injured during flowering by late spring frosts. When planting is delayed into February or March, give preference to early maturing varieties, such as California Mariout or Arivat. Club Mariout, although a mid-season variety, also responds well to late planting.

In northern mountain valleys at elevations of around 3,000 feet or more, where it is necessary to delay planting until spring because of climate, plant as soon as a satisfactory seedbed can be prepared and when the danger of severe frost is past. Well established seedling barley will stand short periods of temperatures down to about 22° F.

METHOD OF SEEDING

Barley can either be broadcast on top of prepared soil by seed-spreading devices such as endgate seeders and airplanes, or placed directly in the soil with a drill.

Cover broadcasted seed by a harrow or disk, promptly after distribution. Broadcasting is fast and can be done on soil too wet for a drill. However, use it only when you are assured of sufficient subsequent rainfall to support germination and growth. Do not broadcast seed in the spring, especially if the rainfall period is over. More uniform stand, less lodging, better weed control, and usually higher yields are obtained with a drill. Where drilling is used as a method of seeding, the amount of seed used per acre can be reduced by 15 to 20 per cent over that broadcast.

DEPTH OF PLANTING

The best depth for planting or covering barley is between 1 to 2 inches. It is not advisable to plant barley deeper than 2½ inches. In clay soils or soils which have a tendency to crust, shallow planting is preferable.

IRRIGATION

Lack of moisture is one of the main factors which limit barley yields in many areas of California. Supplemental irrigation is becoming rather general wherever water is available. The amount of water used and the time of irrigation will vary, depending upon soil and environmental conditions. Timing is most dfficult in areas where irrigation is used to supplement rainfall. While irrigation practices will vary according to local conditions, certain general rules apply.

In deep, permeable soils the roots of barley will penetrate 4 to 5 feet. Arrange irrigation practices to provide moisture during the growing season to that depth. In areas which rely entirely on irrigation, three irrigations totaling about 15 to 20 acre inches per acre are normally sufficient. Apply the first irrigation prior to planting and wet the soil to a depth of 4 to 5 feet. Irrigation immediately after planting may leave the soil in a compact and crusted condition which can interfere with the subsequent normal development of the plant.

With fall-sown grain, cold weather generally prevails during the early growth stages. The pre-irrigation should be sufficient to sustain the plants until the jointing stage, when the first crop irrigation may be needed. Apply the second crop irrigation, if needed, in the boot stage just before flowering. When only two irrigations are used, start with the pre-irrigation and delay the crop irrigation until late jointing or when the plants are in the boot stage. Moisture stress between the jointing and heading stages is more injurious to the plants than in the earlier or later stages of development. Irrigation after heading or milk stage is seldom beneficial or economical. Where water penetration into the soil is a problem you may have to irrigate at more frequent intervals.

In areas or seasons of high rainfall, fall and early spring irrigation may result in water-logging, which can be harmful to plant growth. Even dry-farmed barley can be "drowned out" by too much rain. This is especially true on less permeable, claypan or hardpan soils. Excessively wet soils lack adequate aeration, may be low in nitrogen due to leaching, reduced nitrification or loss of nitrogen into the air, and generally favor root-rotting organisms. Any one or all of these factors may be operating when barley is "drowned-out."

FERTILIZATION

Barley fertilization is a local problem. The response to fertilizers depends on several factors, such as inherent fertility of the soil, cropping and fertilizer history, and rainfall. Economic responses have been obtained with nitrogen and phosphorus, alone and in combination. In some areas sulfur alone and in combination with nitrogen and phosphorus have given improved growth and yields. Field trials to date have shown no response to potassium.

Nitrogen deficiencies are widespread but not in well-defined areas. With the general decrease of organic matter in the soil, an increase in responses to nitrogen may be expected.

Under dry-farmed conditions, especially if rainfall is likely to be around 12 inches, applications of 20 to 30 pounds of nitrogen per acre (100 to 150 pounds of ammonium sulfate or its equivalent) are usually sufficient. In recent University fertility studies on dry-farmed, biennially cropped soils (in areas of less than 12 inches annual rainfall), application of nitrogen was often unnecessary and economically unprofitable. In dry-

farmed areas with 15 inches of rain or more, up to 40 pounds of nitrogen may be profitable. Under irrigated conditions, applications up to 80 pounds of nitrogen per acre have given economic responses. In all cases, if considerable straw or non-legume crop residue is incorporated in the soil before planting, it may be desirable to increase the amount of nitrogen by an additional 15 to 30 pounds per acre to prevent nitrogen deficiency.

Nitrogen usually stimulates plant growth. Excessive applications often cause overstimulation, ultimately resulting in severe lodging, delayed maturity, increased susceptibility to diseases and exhaustion of soil moisture before the grain is mature.

Unfortunately, soil tests for measuring the supply of available soil nitrogen are not reliable under the wide diversity of growing conditions found in California. Nitrogen needs can best be determined by actual field trials.

When you grow barley following satisfactory yields of alfalfa, irrigated pasture, and heavily fertilized row crops, or when you have turned under a satisfactory legume green manure crop, you may greatly reduce or eliminate the amount of nitrogen applied. Crops following a year of fallow may show little or no response to nitrogen unless the annual rainfall exceeds 10 to 12 inches, in which case 15 to 20 pounds of nitrogen per acre may be profitable.

Various forms of nitrogen fertilizers are available and, if properly applied, appear to be equally effective per unit of nitrogen. Time and method of application varies with the type of fertilizer used. Since all dry sources are soluble in water, you may make surface applications but, in general, it is more satisfactory if you work the fertilizer into the soil. Place aqua and anhydrous forms into moist soil to a depth of 6 inches. Late-winter applications offer promise and split applications might be considered on sandy soils, on soils subject to heavy leaching, or in circumstances when you try to adjust nitrogen application to available water supplies.

Phosphorous-deficient soils can be broadly outlined as to regions, types and origin. You may expect favorable responses to phosphorus on the generally "red" colored soils on the terraces and foothills along the margin of the Sacramento and San Joaquin valleys. These soils often have poor drainage and strongly developed claypans and hardpans near the soil surface. Many upland soils developed in place from hard rock or softly consolidated materials also respond to phosphorus as do some peat and muck soils.

The need for phosphorus fertilization can be successfully predicted by the proper selection of soil test methods. Evaluation of available soil phosphorus by the methods of water extraction and sodium bicarbonate extraction have given better than 90 per cent accuracy and these are being used by commercial laboratories. However, such tests should be corroborated by actual field trials. Unlike nitrogen, excessive amounts of phosphorus have no harmful effect on plant development and will remain in the soil for future use.

Phosphorus sources, best suited for use in California, supply most of the phosphorus in a water-soluble form. The materials, however, do not move far from the point of application; always incorporate them into the soil before or at the time of planting. It is important that a supply of available phosphorus be in the immediate proximity of the seedling root to help the plant get started. Phosphorus-bearing fertilizers usually give best results if drilled alongside or below the seed. Use a combination seed and fertilizer drill. Top-dressed phosphorus is not efficiently used and may not benefit the crop. Rates of application usually vary from 20 to 80 pounds of P_2O_5 per acre. In many soils deficient in both phosphorus and nitrogen, no re-

sponse will be obtained with the application of either one separately, but only when applied in combination.

Mixing seed and fertilizer. When no more than 100 to 150 pounds of chemical fertilizer are applied per acre, some growers have physically mixed the grain seed and fertilizer and successfully drilled the two together. In doing so, they always run the risk of fertilizer injury to the seeds or seedlings. Nitrogen-bearing fertilizers are more likely to give difficulty under these conditions than fertilizers containing only phosphorus.

RATE OF SEEDING

The amount of seed varies considerably throughout the barley-producing areas. Many factors, such as rainfall, soil fertility, time and method of planting, variety, weed competition and utilization must be considered. The barley plant has the ability to adjust to varying conditions by sending up one or more stems (tillers), varying the number of kernels per head and plumpness.

Rates of 60 to 80 pounds per acre are normally used when drilled. In areas of limited moisture, rates as low as 30 to 50 pounds may be more desirable. When you do your seeding by broadcasting, increase rates by 25 per cent over those used in drilling.

Gradually increase the amount of seed used per acre from fall to late winter planting. Late spring planted barley tillers considerably less than that planted early; hence, more seed is needed. With extremely late spring planting in areas where supplemental water is not available, use lower rates to adjust the stand to the available moisture. Heavier rates will provide greater plant competition for weed control, but rates above 90 pounds are seldom justified. Stand establishment on poor seedbeds or with adverse weather conditions require the heavier rates. Overseeding is more hazardous to yield than underplanting. Excessive stands may exhaust moisture and fertility before ripening, or cause excessive lodging, resulting in low production, pinched kernels and low bushel weight.

WEED CONTROL

The troublesome weeds of barley fields may be divided into two general groups: (1) the grassy weeds, such as wild oats, annual rye grass and ripgut brome and (2) the broadleaved weeds, such as wild radish, mustard, star thistle, and fiddleneck. Control of all types is abetted by good farming practices. A thrifty and vigorously growing crop (based on good seedbed preparation, optimum planting date, proper fertilization practices, correct seeding rates, use of adapted varieties, etc.) will provide active weed competition and help to smother out many weeds. The use of weed-free seed is one of the most effective methods of reducing the cost of weed control.

Timeliness of operations is the key to successful weed control, especially for wild oats. Delaying seedbed preparation until the fall or winter rains have germinated the weed seed is fairly effective. Once the seeds of wild oats have been plowed into the soil, they may lie dormant for several years, germinating and growing when they are returned to the surface by subsequent tillage. Since wild oats normally mature and drop their seed before the barley crop is ready for harvest, cutting heavily infested barley fields for hay, before the wild oats shatter, greatly reduces the amount of seed returned to the soil and may greatly reduce trouble during the following years. Drilling the barley seed, and use of

drilled (placed) phosphorus fertilizer (where this element is deficient) also help to control wild oats.

With continuous grain culture, even though the best production practices are followed, it is often necessary to include a fallow every third or fourth year. During the fallow year it is possible to destroy several successive weed crops, including summer-growing weeds. Summer tillage of the fallow should be shallow in order to avoid bringing deep seed to the surface.

Most of the commonly occurring broadleaved weeds can be controlled by spraying with an appropriate herbicide. A number of chemicals have been proven successful and more are being tested. For latest recommendations consult current spray leaflet or see your Farm Advisor.

HARVESTING

Practically all California barley is combine-harvested. Proper adjustment and operation of the combine determines the quality and efficiency of the harvest operation. Recent tests by the departments of Agricultural Engineering and Agronomy have shown in one case a threefold increase in loss from the rear of the combine when the rate of straw intake was increased from 100 to 140 pounds per minute. In other tests, header loss was reduced from 400 to 100 pounds per acre when the reel speed ratio (reel peripheral speed divided by forward speed of the combine) was reduced from 3.25 to 1.5, coupled with minor changes in reel position. The percentage of broken and skinned kernels increased from 5.5 to 11.4 per cent when the cylinder peripheral speed was increased from 3,800 to 4,850 fpm without additional adjustments. Excessive kernel damage seriously affects the quality of the barley for seed and malt. Proper adjustment of the combine is not a constant, but varies with the time of day, the moisture content, quantity of straw, yield, variety and various other factors. Frequent daily adjustment of the combine is required to compensate for these variations.

Barley is ready for harvest when the moisture content is 14 per cent or less. If you must harvest while there is still free moisture (dew) on the kernels, blend such grain with dry grain for safe storage. When fields are badly contaminated with green weeds, it is often advisable to windrow the barley rather than to combine direct. After the weeds have dried, the trashy weeds including weed seeds are readily removed from the grain during combining.

Avoid overloading the machine. With the 12-foot self-propelled combines used in the various tests, seed losses became excessive when feed rates (straw and chaff input) exceeded 100 to 125 pounds per minute. Overloading of the straw walker and the cleaning shoe either from excessive feeding rates or improper machine adjustment, results in high loss of free-seed from the rear of the combine. In addition, overloading of the cleaning shoe results in larger amounts of free-seed being recirculated in the tailings, which increases the amount of skinned and broken kernels.

Header loss can be reduced to a minimum by proper adjustment of the reel. A fixed-bat reel ordinarily should be 6 to 10 inches ahead of the cutter bar and at a height such that the bats contact the straw just below the heads. A pick-up reel, when used in lodged crops should be lower and a little farther forward. The peripheral speed of the reel should be about 25 to 50 per cent greater than the forward speed of the combine.

Although maximum cylinder speeds and minimum clearances are desirable to keep seed losses low, the adjustment of the cylinder and concaves will be determined primarily by the amount of seed damage that is acceptable for the

Harvesting Hannchen barley for malting—Tulelake, California. Modern combines can harvest lodged grain, but University of California plant breeders are developing varieties with improved straw strength.

anticipated use of the barley. For seed and malting purposes, minimum damage and high germination are essential. Excessive kernel damage increases the hazards from stored insects and, therefore, must be considered even with feed barleys. For machines with a rasp bar cylinder, a peripheral speed of 5,000 to 5,500 fpm and a cylinder-concave clearance of ¼ inch should be satisfactory for harvesting feed barley under the warm, dry conditions of the interior valleys. With a spike-tooth cylinder similar cylinder speeds with a clearance of 5/32 of an inch between cylinder and concave teeth should be satisfactory. Always use as few rows of teeth in the concave as possible that still will thresh the grain clean. Two to four rows of concave teeth are generally required. However, six rows may be needed for tough conditions. It is usually better to use fewer rows of teeth with the concave set high than to use more rows of teeth with the concaves low.

Considerably slower cylinder speeds are necessary when threshing barley for seed or for processing into malt. In the latter case, it is better to allow a small portion (1/16 inch) of the awn to remain attached to the kernel than to attempt complete removal which often may lead to partial loosening of the hull.

STORAGE

Barley can be safely stored if the moisture is less than 14 per cent. Green weed seeds, leaves and stems are often the major reasons why grain heats in storage; it is advisable, therefore, to clean very trashy grain before storage. Frequent circulation of the grain during the early storage period may be sufficient as a safety measure if the trash is not excessive.

Insects are a constant threat to grain in storage. Standing grain in the field is usually free of storage insects; contamination occurs later during handling and storage. Be sure to clean thoroughly storage bins and all equipment before using them in harvesting and handling grain. Keep areas around the storage units free from sources of infestation, such as nests of birds, bees, ground squirrels, rats and similar pests.

Three important factors influencing the abundance of insects in stored grain are: cleanness of the grain, moisture content, and temperature. A number of insects, such as the saw-toothed grain beetle and Indian-meal moth, cannot attack sound grain, but are confined in their feeding to broken or damaged kernels, plus a wide variety of food products. Grain with a moisture content of less than 10 per cent is relatively safe from these "secondary" feeders. However, they are capable of obtaining moisture from dust and dockage and, consequently, can maintain their growth even though moisture in the grain is below 10 per cent. Clean, sound grain will help keep losses to a minimum.

The more serious pests, such as the granary weevil, Angoumois grain moth and the Khapra beetle are capable of attacking sound grain. Except for the Khapra beetle, grain with less than 8 per cent moisture is relatively safe from this group. The Khapra beetle can feed at a much lower moisture content.

Insect activity is greatly retarded by low temperatures. In general, insect reproduction and feeding damage is limited if the temperature of the grain is below 60° F. Care must be taken to avoid hotspots developing in the storage unit since insect infestation can develop there.

Occasional aeration, using unheated atmospheric air, helps to keep grain in condition.

A number of insecticides and fumigants are available to assist in stored grain insect control. Since rules and regulations regarding their usage have been set by law, check with your local Farm Advisor or Agricultural Commissioner before treating your grain or facilities. Because damage to germination and excessive chemical residues can result from overtreatment, carefully follow the manufacturer's directions.

PRODUCTION OF MALTING BARLEY

Growing barley for malting requires special management procedures. Only three varieties grown in California, Atlas strains, Winter Tennessee and Hannchen, are currently acceptable to the malting industry. Purity—in terms of varietal mixtures, other crops, and weed seeds—is extremely important.

A well-filled, mellow kernel is desired. The crop should stand in the field until fully ripe. If growth is arrested by drought, disease or premature harvesting, the kernels are likely to be "steely" and undesirable. A protein content higher than about 10 per cent is not desirable, except for the variety Hannchen, where a protein content of 12 per cent is acceptable. Excessively high protein may result from the barley following a legume crop, from heavy rates of nitrogen fertilization, from premature ripening because of drought or disease, and from late planting. Endeavor to avoid all of these factors if you produce barley for malting.

One of the most important requirements of malting barley is high germination. Extreme care must be exercised during harvest, processing and storage to avoid skinning and breaking of the kernel (see harvesting). Some difficulties have been experienced with germi-

nation from barley put in storage at temperatures over 90°F. An important point to remember is that malting barley is considered a food and thus rigid standards in terms of cleanliness and sanitation have been imposed under provision of the Pure Food and Drug Act.

Plant malting barley early to assure a well-developed kernel. Avoid extremely fertile soil, since lodging and a high protein content might result. In most cases, except in the Tulelake Basin of northern California, barley grown under irrigation is usually by-passed by malt manufacturers because they have found that dry-farmed barley is best for their purposes.

Many factors which make for quality are beyond the control of the farmer. The influence of environmental conditions, while recognized, are not fully understood, except for the fact that certain areas consistently produce better quality (chemically) than others. This has led to the establishment of so-called "malting-barley producing areas" to which the industry consistently looks for their needs. Areas currently in favor with the buyers include the Tulelake Basin, areas on the west side of the Sacramento Valley, foothill areas on the east side of the upper San Joaquin Valley, and interior valleys in the central coast district. As factors controlling quality become more readily understood, the opportunity to extend such areas through crop management offers a definite possibility to barley growers.

Typical malting barley producing area near Esparto, California. Note fallowed field in background.

BARLEY DISEASES

Some diseases can be completely controlled by seed treating; losses from others can be minimized by proper cultural management; for some no practical control exists. In all cases, losses can be kept low by following good cultural practices, careful selection of adapted varieties, utilization of disease-free seed and seed treatment.

In California all barley seed should be treated with a fungicide before planting; organic mercurials such as Ceresan M, liquid Ceresan or Panogen are recommended. Wherever necessary for wireworm control, an insecticide such as lindane may be used in combination with the fungicide. Follow the manufacturer's recommendations as to amounts and treating procedures.

The important barley diseases in California are stripe, covered and loose smut, root and crown rot, scald, powdery mildew, net blotch, and yellow dwarf.

Stripe originates from infected seed. First symptoms are long, pale-green stripes on the leaves. As the leaves reach full development these stripes turn brown, and the leaves may split along the stripes. Diseased plants are stunted and usually die at the heading stage. Occasionally seeds are produced which appear in a threshed sample as shriveled underdeveloped kernels with brown discoloration. Spores of the fungus, which adhere to the healthy kernels or are located beneath the husk, germinate when the seed is planted and infect the seedling. This disease is readily controlled with the organic mercury fungicides.

Covered and loose smut are identified by the dark powdery spore masses which destroy the kernels in the head. Loose smut normally destroys the entire kernel structure, including the awns. The spores are disseminated by the wind, leaving only the bare stem when the crop is mature. In the case of covered smut, the awns and parts of the husk are not destroyed, and the spores remain enclosed in the partially destroyed husk until harvest. During combining the spore masses are ruptured and the spores adhere to the healthy kernels. Both covered and loose smut are seed-borne, but only the covered smut is controlled with chemical seed treatment. Loose smut can only be controlled by the hot-water treatment or by a special cold-water soaking method. These methods, especially the hot-water treatment, are very exacting and can only be used where accurate temperature control is available. Likewise, treating large amounts of seed is not feasible. At present, the only practical means of controlling loose smut is to plant disease-free seed. Since infested seed cannot be distinguished from healthy seed, field inspection of the seed field before harvest is essential.

A third type of smut, nigra or black loose smut, also occurs in California. It looks like loose smut, and is often confused with it. However, nigra is readily controlled with chemical seed treatment and should be of no trouble in commercial fields.

Root rot is usually applied to all diseases that affect the roots, crown and other basal parts of the plant. Symptoms vary from a stunted, unthrifty appearance to actual death of the plant. Discoloration of the roots, crown and basal part of the stem is usually evident. Since destruction of these tissues interferes with the normal uptake of water, plants may appear to be suffering from drought. This is especially true when the plants are subjected to stresses, such as high temperatures, dry winds, etc. Infected plants may have a bleached appearance and, if stresses are imposed at flowering

time, sterility may result. A number of soil-borne organisms are responsible for root rot and tend to multiply in the soil when susceptible crops are grown year after year. These diseases are affected markedly by environmental conditions, and although present in the soil, may not cause noticeable damage every year. Fortunately, oats are resistant to most of the root rot organisms and fairly good control may be obtained by including oats in the rotation about every third year. Sudangrass in the rotation has also helped to control root rots. Wheat is equally as susceptible as barley.

Scald, net blotch and powdery mildew are foliar diseases which spread from plant to plant by wind-borne spores produced on infected tissue. These diseases are perpetuated from year to year on volunteer barley plants or other grass hosts. In the case of scald and net blotch, diseased straw and stubble serve as the primary means of reestablishing the diseases. Clean cultivation, sanitation and rotation help to minimize their occurrence. Scald and net blotch are more severe on very early sown grain; delayed planting to the optimum period will reduce the incidence of these diseases. Crop management, to reduce lodging, also helps. However, once scald and net blotch have become established, their subsequent spread depends primarily on favorable climatic conditions. There is no effective method for controlling the development and distribution of the wind-blown spores. *Scald* appears as oval-shaped spots with pale or white central areas surrounded by irregular brown margins. *Net blotch* appears as brown, linear lesions which exhibit a network of dark brown lines within an area of lighter brown. With both diseases, the spots enlarge and fuse with others, often forming a continuous diseased area across the leaf. When this occurs, movement of food and water is stopped and the entire leaf dies. The damage results from defoliation of the plants and the reduction of photosynthetic areas. With both diseases, lesions may form on the kernels, producing a blighted and discolored kernel. Seed treatment kills the fungus carried on the seed.

Powdery mildew first appears as small, white or light-gray spots of cottony threads or mycelium which later enlarge and give a powdery appearance, due to spore formation. Adjacent spots fuse and eventually may cover the entire leaf surface. A yellowing, followed by browning and gradual drying of the leaf occurs. On the older diseased areas small, black reproductive bodies may develop. Severe infection in the seedling stage may so weaken the plant that death may result. This is especially true on late-sown grain. With the advent of hot dry weather, the spread of the disease may be retarded and the new leaves will be free from mildew. Under these conditions, the plants appear to recover fully and produce normal yields. However, even under these conditions, reductions in yield of 27 per cent have been measured, usually resulting from fewer kernels per head. When conditions are favorable, infection can continue throughout the life of the plant. In these cases, kernel weight is reduced as well as the number of kernels per head. Although losses from mildew may be minimized by avoiding late planting, no effective means of control is currently available.

Yellow dwarf is potentially the most destructive disease of barley in California. The disease was unknown before 1951, when it occurred throughout the state. Yellow dwarf is caused by a virus which is transmitted from plant to plant by at least five different species of aphids. The disease is characterized by a brilliant golden yellowing of the leaves and moderate-to-severe stunting. The younger the plants are at the time of infection, the more severe the damage. In the case of extremely susceptible varieties, the plants

may be killed. Reductions in yield greater than 70 per cent have been measured. The severity of the disease can be decreased by well-timed planting during the recommended period from November 15 to January 15 so that the developing plants are well advanced by time of increased aphid activity in the spring. In years of early fall rain, extremely early plantings may be injured as the result of late flights of aphids in the fall. Reducing infection by controlling aphids is not economically feasible.

Other diseases, such as the rusts and stripe mosaic, may occur but are of little economic importance at the present time. Stem rust is caused by the same organism which attacks wheat. However, it never has been severe on barley. There is no practical means of control.

Stripe mosaic is often confused with the true stripe, but is caused by a seed-borne virus. The symptoms vary with the variety, but the most frequent symptoms are short to long, bleached, yellow or light-green stripes, which may become brown. In addition to being seed-borne, it is spread from plant to plant by contact. Seed treatment is not effective and only clean, disease-free seed should be used. This disease, although not generally prevalent in California at the present time, could become extremely serious if our seed stocks become widely infected. Once it gets into a seed stock, it is virtually impossible to eliminate. The disease is extremely important in certain barley-producing areas of the United States.

Control of diseases by planting resistant varieties

The use of resistant varieties, whenever available, is the best method of eliminating losses from diseases. Unfortunately, only a few such varieties are available at the present time. Certain varieties, however, possess some tolerance to certain of the diseases and are seldom damaged by them. Rojo is fairly tolerant to yellow dwarf, scald and net blotch. Winter Tennessee has good tolerance to net blotch and, to some extent, scald. Consider these factors when selecting a variety in areas where such a variety is adapted. Atlas 46 and Atlas 54,

Seeding barley near Paicines, California. This is a good seedbed for dry farmed barley. Note cloddy condition of soil. The equipment is a CC seeder-cultivator which distributes the seed on the soil surface and then harrows it into the soil to a depth of about 1½ to 2 inches.

which were formerly highly resistant to scald and mildew, are susceptible to new strains of the diseases which are now prevalent. Both varieties are still recommended where adapted since they do have resistance to many strains of the diseases.

New strains of a disease may originate in several ways, most of them beyond the control of either the grower or the plant breeder. However, strains (and other diseases) are prevalent in other states which are not present in California, and extreme caution should be exercised when bringing in varieties from other states.

An active university program is under way to develop barley varieties resistant to many of the major diseases. Some improved varieties will be available in the near future. Since new strains of disease may arise which will attack resistant varieties, growers should use every practical production practice which will help keep disease problems in check.

INSECTS OF BARLEY

Wireworms are small, yellowish or brown worms about one inch long; they are immature stages of click beetles. They feed on seeded grain and the underground parts of the plant, thus thinning stands. Treating the seed with lindane before planting has been fairly effective in reducing damage. Such treatment should be combined with a fungicide for a combination pest and disease protection measure.

Aphids. Populations on occasions have built up extremely high to the point that they seriously damaged young barley. Under these conditions, satisfactory control was obtained by spraying with recommended chemicals such as parathion. Consult your local Farm Advisor for current recommended control methods. Normally natural aphid predator insects such as ladybird beetles and syrphid fly larvae effectively hold aphid populations in check in barley fields. Chemical control should only be used in extreme emergencies since most chemicals will also kill these beneficial insects.

Black grass bugs. These black bugs (*Irbesia* spp) damage barley around the edges of fields where they move in from wild and other grasses. They suck the barley plant juices, causing a white blotching of the leaves. In severe infestations the plants can be killed. Parathion dusts or sprays will effectively control these pests.

Hessian fly is occasionally a problem in areas near the northwestern reaches of San Francisco Bay and in southern California coastal counties. The flies lay their eggs on the upper surface of the leaves of young cereal plants, including barley. The eggs hatch in 3 to 12 days, and small red maggots (larvae) make their way down the leaf and behind the sheath, where they feed on the tender plant tissues. The maggots are full grown in 2 to 4 weeks. They are then glistening white, but soon turn brown, forming "flaxseed" or puparia. Adults emerge from the overwintering "flaxseeds" in early spring to lay their eggs. Small plant tillers die; jointed tillers often break over and fall to the ground before harvest. Adults emerging from "flaxseeds" in stubble and in volunteer plants of harvested fields reinfest early fall-seeded fields. The most practical control methods are completely plowing under crop residues in the fall as soon as possible and maintaining a high level of fertility.

BARLEY VARIETIES

Varietal selection

While high productivity is the usual goal in selecting a variety, numerous varietal characteristics contribute to the over-all success in obtaining maximum production and must be carefully considered. Because of the wide diversity of California environmental conditions, no one variety is satisfactory for all areas, nor in any one area where a diversity of cultural practices is employed.

One of the most important factors determining varietal adaptation is time of maturity. Choose the variety which makes maximum use of the favorable growing season characteristic of your area. Select early maturing varieties where the growing season regularly is shortened by the onset of high temperatures, moisture deficiencies, or by late planting dates. Use midseason or late maturing varieties in areas where late spring frosts are likely to occur or an extended growing season exists. California Mariout, the earliest maturing variety available in California, is not recommended for early planting in the Sacramento Valley. However, when planting is delayed until after January 1, California Mariout can be successfully grown there. In the San Joaquin and Imperial valleys, it is recommended for both early and late planting.

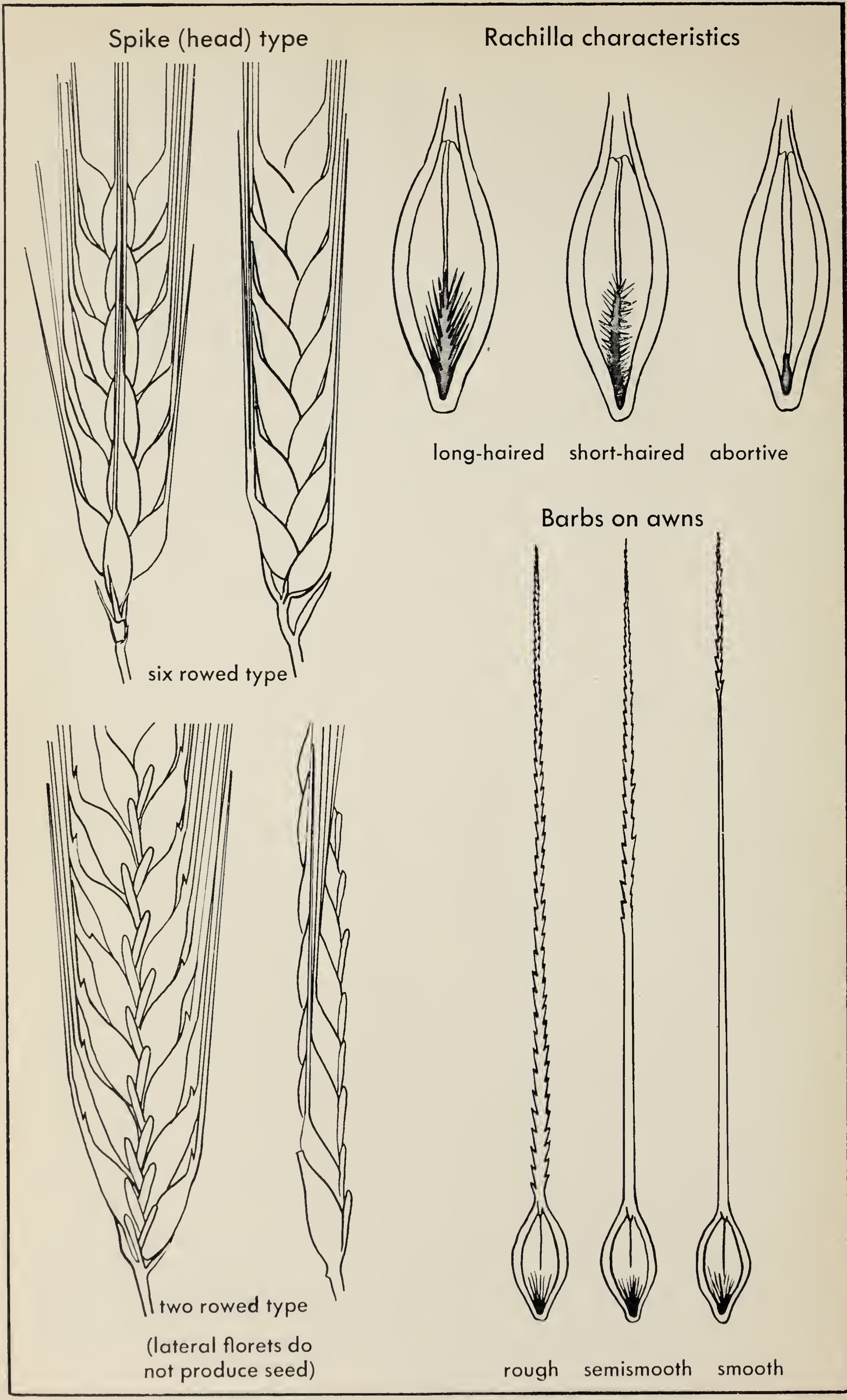
In some cases, varietal selection is based on one or few specific characteristics. For example Winter Tennessee will tolerate wetter soil conditions (such as exist in riceland areas) than the other varieties. Consequently, it is often grown on land subject to overflow, or waterlogged conditions, whereas under drier conditions in the same area other varieties may be more productive.

Malting and brewing standards impose a rigid varietal requirement. Only three California varieties, Atlas, Winter Tennessee and Hannchen currently are acceptable for this purpose. In some cases feed barleys may be slightly more productive than malting varieties, but premiums paid for malting barley usually offset the lower yield.

Within the next few years a number of new and improved varieties will be available for commercial production. Many of these will be improved strains of existing varieties. Unless the basic varietal characteristics have been changed, these improved strains retain the name of the prototype variety, and only a number is added to the name. The number indicates the year in which the variety was available for commercial production. These new strains can be substituted for the unimproved type without any change in cultural management. The new strains will be superior to those which they replace with regard to the specific characteristics which were added, whether it be disease resistance, stiff straw, or shatter resistance. Cumulative additions over the years will go far in increasing the usefulness of the varieties, increasing and stabilizing production, and making handling easier.

Agronomic and disease summary

The agronomic characteristics and performance records of the principal varieties are summarized in the tables on pages 26, 27, and 28. Since many variables enter into the yield of a particular variety, the results which are presented in these tables can be used only as a guide to varietal recommendations. The variability of climatic and production factors existing within a small geographical area often necessitates the growing of two or more varieties within that area, often on one ranch. However, the results of the statewide tests (table on page 29) do give a general picture as to varietal adaptation. For example, the consistantly high production of Arivat over the entire state implies a wide adaptation. On the other hand, the lower yields of Califor-


Spike (head) type
six rowed type
two rowed type
(lateral florets do
not produce seed)
Rachilla characteristics
long-haired
short-haired
abortive
Barbs on awns
rough
semismooth
smooth

nia Mariout, when tested in the Sacramento Valley and northern California, confirm commercial experience with this variety in these areas, which is not favorable except for late planting. The small yield differences between many of the varieties emphasizes the point that, in many cases, other factors, such as disease reaction, straw strength, maturity, etc. are more important than yield in the selection of a variety. These special features are summarized in the tables on pages 26, 27, and 28.

Varietal description

A description of the leading barley varieties grown in California, together with a botanical key for their identification is given below. All varieties mentioned below are spring types, lacking sufficient winter hardiness to withstand prolonged winter freezes which characterize elevations over 3,500 feet in California, except in the Antelope Valley. In those areas spring planting is recommended.

Key to Varieties of Barley Grown in California:

A. Spike six-rowed
- B. Awns rough (barbed)
  - C. Rachilla long-haired
    - D. Kernels blue . . . . California Mariout
    - D. Kernels white . . . . Blanco Mariout
  - C. Rachilla short-haired
    - E. Heads dense (rachis internodes short); Kernels white . . . . Club Mariout
    - E. Heads lax (rachis internodes long)
      - F. Kernels blue . . . . Winter Tennessee
      - F. Kernels light blue to white . . . . Atlas 46
- B. Awns semi-smooth
  - G. Rachilla long-haired, abortive on 30 per cent of the kernels; glumes pubescent; kernels white . . . . Arivat, Vaughn
  - G. Rachilla short-haired, glumes glabrous
    - H. Kernels light blue to white . . . . Atlas 54
    - H. Kernel white . . . . Atlas 57
- B. Awns smooth; heads dense; rachilla long-haired; glumes glabrous or nearly so; kernels white; hulls often exhibiting strong purple pigmentation . . Rojo, Hero

A. Spike two-rowed; awns rough; rachilla long-haired; kernels white . . . . Hannchen

Malting types

Atlas 46

History: Atlas 46, an improved strain of Atlas, from the cross (Hanna × Atlas^{8}) × (Turk × Atlas^{8}), was released in 1947 as a replacement for Atlas. The original Atlas strain was a pureline selection made from Coast barley in 1917.

Description: Rough-awned. Kernels light blue to white. Short-haired rachilla. Stiff straw of medium height. Midseason in maturity. Atlas 46 differs from Atlas in being resistant to many strains of powdery mildew and scald. Although races of these diseases are present in California which attack Atlas 46, its resistance is sufficient in many years to provide considerable protection against excessive losses. This is particularly true in the case of scald.

Adaptation: Widely distributed throughout California. It is not recommended in areas subject to early stresses of moisture or high temperatures such as the Imperial Valley or the southern portion of the San Joaquin Valley. Does best on soils with high water-holding capacity.

The bulk of its acreage is in the Sacramento Valley.

Atlas 54

History: A composite of 48 F_3 and F_5 lines from the cross (Lion × Atlas[11]) × Atlas 46[2], developed in a cooperative project by the U. S. Department of Agriculture and the University of California. Released to growers in 1954 as a replacement for Atlas 46.

Description: Atlas 54 is a semi-smooth awned strain of Atlas 46. The kernels average slightly larger than those of Atlas 46 and are predominately white. In all other respects, it is identical to Atlas 46.

Adaptation: Same as Atlas 46

Atlas 57

History: Atlas 57 is a composite of 119F_3 lines resulting from combining colorless aleurone selections from Atlas 54 × Atlas 46. Developed in a cooperative project by the U. S. Department of Agriculture and the University of California.

Description: Kernels uniformly white. Identical to Atlas 54 in all other respects.

Adaptation: Same as Atlas 46 and Atlas 54 which it will eventually replace.

Hannchen

History: Hannchen is a pureline selection from the variety Hanna. It was introduced into the United States from Sweden by the U. S. Department of Agriculture in 1904 and released to growers about 1908.

Description: Hannchen is a two-rowed type, midseason to late in maturity with tall and moderately weak straw. Rough-awned. Kernels white with long-haired rachilla. It is resistant to the races of stripe occurring in California.

Adaptation: Extensively grown in the Tulelake area and to a limited extent in other areas of northern California, where its quality is suitable for malting and brewing. It is not adapted to the warmer, drier areas of California. Under these conditions it is subject to severe shattering and its quality is not satisfactory for brewing. In general, will yield only about 85 per cent of well-adapted six-row types.

Winter Tennessee

History: The history of Winter Tennessee is somewhat obscure. However, it is believed to be a selection from the variety "Coast," which was originally grown in California. The selection was made at the University of California and distributed to growers in 1916.

Description: This variety is a Coast type with spring growth habit and does not resemble the true Tennessee Winter type grown in the southeastern states. The kernels are moderately blue, darker than Atlas but lighter than California Mariout. Short-haired rachilla. Midseason to late in maturity. Straw tall, and moderately weak. Moderately resistant to net blotch and scald.

Adaptation: Distribution restricted to areas where climatic and soil conditions favor the development of midseason varieties. Does better than other California varieties on wet and poorly drained soils.

Feed types

Arivat

History: Pureline selection from the cross Atlas × Vaughn. Released by the Arizona Experiment Station in 1940.

Description: Medium early in maturity, medium height and stiff straw. Semi-smooth awns. Kernels white with a thin hull, subject to skinning during threshing. Rachilla long-haired, abortive on 30 per cent of the kernels. Moderately resistant to stripe, with some tolerance to scald.

Adaptation: Widely adapted throughout California; responds moderately well to late planting. Because of its similarity to

Vaughn, coupled with a slight increase in productivity, it is suggested as a replacement for Vaughn. Vaughn is no longer recommended for production in California.

California Mariout

History: California Mariout undoubtedly came from the dry-hill region west of Lake Mariout in Egypt. It was first tested at Davis, California, in 1911 from seed supplied by the E. Clements Horst Company of San Francisco. Distributed to growers in 1912.

Description: Earliest maturing variety grown in California. Straw is short, but weak. Rough awned. Kernels dark blue; long-haired rachilla. Susceptible to the major diseases.

Adaptation: Does well where moisture is limiting—San Joaquin and southern California. Recommended for late planting in the Sacramento Valley. Fairly tolerant to alkaline conditions. May be damaged by late spring frosts in the Sacramento Valley and higher elevations when planted early. Lodging will be serious if planted early on fertile soil.

Blanco Mariout

History: A white-seeded California Mariout type barley derived from the cross, male sterile Club Mariout × California Mariout[7]; a composite of 192 lines. Developed in a cooperative project by the U. S. Department of Agriculture and the University of California.

Description: Its gross plant appearance, yield and disease responses closely parallel those of California Mariout. It is 2 to 3 days later in maturity. The colorless aleurone (white) distinguishes it from California Mariout, although the seeds are somewhat longer and heavier. Because of wax (bloom) on about one-third of the spikes, the glumes on this fraction present a blue-gray appearance rather than the characteristic yellow-green glume color of California Mariout. Some diversity in spike density may sometimes be observable. Rachilla are slightly variable in length, with about 10 per cent aborted, very short, or very long. Rachilla hairs are long, but vary in density.

Adaptation: The same area as California Mariout. Since Blanco Mariout shows no gain in disease resistance or yield over California Mariout, it probably will only partially replace a portion of that acreage.

Club Mariout

History: Club Mariout was introduced by the U. S. Department of Agriculture from Egypt in 1903. First tested in California in 1904. The first commercial acreage originated from a shipment of seed from Oregon in 1919.

Description: Rough awned. Midseason in maturity. The straw is weak and moderately tall. The head is short and somewhat compact, being wider at the base and tapering toward the tip. Kernels large, yellow, short-haired rachilla. Excellent for rolling. Susceptible to all major diseases.

Adaptation: General, responds well to late planting. Late plantings may be subject to heavy damage from yellow dwarf disease. Fairly resistant to shattering.

Hero

History: Hero is of hybrid origin and came from the cross Club Mariout × Lion. Hero was first brought to California in 1915, and distributed to farmers in 1924.

Description: Plants are of medium height, weak and medium late in maturity. The awns are smooth and the awn types may have a deep purple color when the kernels are filling. The color may persist after maturity. The head is short and somewhat compact. Kernels are white, but may appear gray due to purple pig-

CHARACTERISTICS OF CALI

Variety	Per cent of California acreage 1960	Kernel characteristics		Awns	Maturity
		Color	Ranchilla hair		
		B = Blue LB = Lt. blue W = White	L = Long S = Short	R = Rough SS = Semi-smooth S = Smooth	E = Early M = Medium L = Late
Arivat	21.3	W	L	SS	M
Atlas 46	13.5*	LB&W	S	R	M
Atlas 54	..	LB&W	S	SS	M
Atlas 57	..	W	S	SS	M
Blanco Mariout	..	W	L	R	E
California Mariout	42.0	B	L	R	E
Club Mariout	8.1	W	S	R	M
Hannchen	3.0	W	L	R	L
Hero‡	1.5	W	L	S	L
Rojo	3.4	W	L	S	M
Vaughn	1.4	W	L	SS	M
Winter Tennessee	5.8	B	S	R	L

* Includes Atlas 54.
† Resistant to many of the prevalent races in California.
‡ Acreage data includes Hero and all other unlisted varieties.

mentation. Rachilla long-haired. Susceptible to all major diseases.

Adaptation: Hero is adapted to the cooler areas along the coast and in the higher mountain valleys. It is not recommended for production in the central valleys or interior southern California. Hero is used extensively for hay because of its smooth awns and leafy stem. It is relatively low in grain production.

Rojo

History: Rojo is a selection from a composite cross made at Aberdeen, Idaho, in 1929. A number of selections from the composite cross were tested at Davis, California. The most promising of these selections was named Rojo and was released to growers in 1944.

Description: In most plant and seed characteristics Rojo can not be distinguished from Hero. However, it is 3–4 days earlier in maturity and has slightly stiffer straw. The awns are more difficult to remove during harvesting than with the other varieties and usually requires additional adjustment of the combine. Rojo is fairly tolerant to net blotch and is more tolerant to yellow dwarf than any of the other California varieties.

Adaptation: Similar to Hero, and because of its stiffer straw, earlier maturity, and higher grain yields it is gradually replac-

FORNIA BARLEY VARIETIES

Plant height	Straw strength	Disease reaction				
		R = Resistant		I = Intermediate		S = Susceptible
MT = Med. tall M = Medium MS = Med.short S = Short	S = Strong M = Medium W = Weak	Powdery Mildew	Scald	Net Blotch	Stripe	Yellow Dwarf
MS	S	S	I–S	I–S	R	S
M	S	S–R†	S–R†	S	S	S
M	S	S–R†	S–R†	S	S	S
M	S	S–R†	S–R†	S	S	S
S	W	I	S	I	S	S
S	W	I	S	I	S	S
M	W	S	S–I	S	S	S
MT	M	S	I	I–R	R	S
MT	W	I	S	I	S	S
MT	M	S	I–S	I–R	S	I
MS	S	I	I	I	R	S
MT	M	S	I	I	S	S

ing Hero in many areas. It is equal to Hero in hay quality. In areas with ample moisture, it competes favorably with Club Mariout and Atlas in grain production, although the difficulty experienced in harvesting has restricted its acceptance.

Vaughn

History: Vaughn is of hybrid origin from the cross Club Mariout × Lion. It was first tested in California in 1924 and released in 1926.

Description: Vaughn and Arivat are indistinguishable in most plant and seed characteristics. Vaughn is 2 to 3 days later than Arivat and slightly taller. Its early growth is semi-prostrate compared with the more erect habit of Arivat. It is fairly resistant to stripe.

Adaptation: General. Requires fertile soil and early planting for maximum yields. It is a poor competitor with weeds. Arivat has been equal to Vaughn in the typical Vaughn areas, is more widely adapted and is affected less by adverse growing conditions. Consequently, Arivat is gradually replacing Vaughn, which is no longer recommended for production in California.

YIELD, HEADING DATE, AND HEIGHT OF BARLEY VARIETIES

Davis, California

Variety	Yield expressed in per cent of Atlas (before 1946) and Atlas 46 (after 1946)				Heading date* April	Height† Inches
	Rod-row tests		1/50-Acre Plots			
	Number	Per cent of Atlas	Number	Per cent of Atlas		
Arivat	12	122	6	131	14	38
Atlas 46	..	100	..	100	17	41
Atlas 54	3	96	..	...	17	41
Atlas 57	3	106	..	...	17	41
California Mariout	28	106	8	113	11	32
Club Mariout	28	93	23	94	18	41
Hero	20	101	19	95	23	42
Rojo	12	121	6	116	20	42
Vaughn	25	114	18	117	15	39
Winter Tennessee	25	94	23	94	23	42

* Average heading date for 10 years or more. November-December planted. In any one year the heading date may vary a week or more in each direction depending upon planting date, growing conditions, disease, etc. Likewise the comparative difference between varieties will vary, and in some years may show reversals.

† Average of ten or more years. Height will vary depending upon growing conditions, planting date, soil fertility, etc.

YIELD OF BARLEY VARIETIES IN CALIFORNIA

Average yields expressed in per cent of Atlas (1929–1946) and Atlas 46 (1947–1957) in Cooperative County Farm Advisor tests during 1929–1957.

Variety	Southern California		San Joaquin Valley		Sacramento Valley		South and Central Coast		Northern California	
	Number of tests	Yield (per cent of Atlas)	Number of tests	Yield (per cent of Atlas)	Number of tests	Yield (per cent of Atlas)	Number of tests	Yield (per cent of Atlas)	Number of tests	Yield (per cent of Atlas)
Atlas 46*	..	100	..	100	..	100	...	100	..	100
Atlas 54	3	108	6	88	8	99	19	99	7	104
Arivat	84	104	76	108	51	106	148	104	23	96
California Mariout	90	111	74	106	44	91	113	109	13	72
Club Mariout	104	99	84	101	64	98	156	99	23	99
Hero	57	102	37	98	11	93	137	100	7	86
Rojo	81	104	74	105	47	103	153	101	17	96
Vaughn	76	99	66	99	35	105	126	100	17	81
Winter Tennessee	22	104	63	94	47	97	73	97	18	98

* Atlas or Atlas derivates appeared in all tests.

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

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